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ABSTRACT

This paper describes the Basic Skills Learning System, a comprehensive curriculum development effort designed to deliver a variety of materials via the PLATO System in the three content areas of reading, language, and mathematics. Design criteria required that the system be individualized, adaptive, and responsive as well as modularized and structured hierarchically, and use performance objectives, the mastery learning paradigm, diagnostic and prescriptive strategies, and a multi-sensory learning format. Discussion focuses primarily on the Basic Mathematics curriculum as an example of the type of instructional material and strategy used throughout the Learning System. (VT)

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BASIC SKILLS MATHEMATICS CURRICULUM DEVELOPMENT FOR CBE

A Paper for a Topic Presentation
at the ADCIS Annual 1978 Conference
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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

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BASIC SKILLS MATHEMATICS CURRICULUM DEVELOPMENT FOR COMPUTER-BASED EDUCATION

The purpose of this paper is to describe the anatomy of the Basic Skills Learning System, a comprehensive curriculum development effort undertaken by the authors and funded totally by the Control Data Education Company. The Basic Skills Learning System was designed to deliver a variety of curricular materials via the PLATO System in the three content areas of Reading, Language and Mathematics. This discussion will focus primarily on the Basic Mathematics curriculum, as an example of the type of instructional material and strategy used throughout the Learning System.

This paper is organized into two sections; the design criteria established for the Learning System and the anatomy of the mathematics curriculum component of the Learning System.

DESIGN CRITERIA FOR THE LEARNING SYSTEM

The broad differences in chronological age, life experiences, and physical and mental health found in this population combine to provide variations in motivational levels and learning rates. An instructional program capable of responding to differences as great as these must use individualized instructional techniques to be successful. The Basic Skills Learning System was designed to deliver individualized, criterion-referenced instruction based on the "mastery learning" approach in a computer based educational learning environment. The system was constructed to fulfill the following requirements:

1. the system must be totally individualized and offers a highly adaptive and responsive learning environment;
2. the individual curricula must be modularized and structured in coherent, hierarchical patterns;
3. the intended learning outcomes of the System must be carefully articulated in terms of performance objectives;
4. The mastery learning paradigm must be employed as a basis for advance;
5. diagnostic and prescriptive strategies must be utilized;
6. a multi-sensory learning format must be employed.

Addressing each of these six criteria in order will reveal how the Basic Skills Learning System accommodated the individual requirements while resulting in a comprehensive system of "courseware".

Criteria Number 1: the system must be totally individualized and offers a highly adaptive and responsive learning environment.

The use of the sophisticated capabilities of the PLATO System which allowed the interaction of the instructions to take into

account each and every student response. The materials developed for the Basic Skills Learning System was designed to adapt the amount and extent of instruction to the individual needs of each student. The common techniques usually employed in CAI "courseware" of self-pacing and individualized branching were further augmented by the ability of the Learning System to handle student controlled selection of instructional techniques while providing for a tailoring of teaching to individual performance. Immediate feedback is provided for each student based on his or her responses. Learners are helped to select the pathway through the material which is most appropriate for their needs.

Criteria Number 2: the individual curricula must be modularized and structured in coherent, hierarchical patterns.

The flexibility of the curriculum lies in its ability to present to the learner a cohesive, comprehensive curriculum organized in a hierarchy of skills from the simple to the more complex. The Basic Skills Learning System curriculum materials specifically address each and every necessary skill in the defined content areas in a manner that does not leave topics unattended or require extensive instruction in any topics already mastered. One of the critical design premises is that students will not be presented instruction on topics for which they have not demonstrated competency in the prerequisite entry skills. This reduces student frustration and increases curriculum effectiveness. Instruction is presented in small, well-defined units which are less intimidating to students than large blocks of material.

Criteria Number 3: the intended learning outcomes of the System must be carefully articulated in terms of performance objectives.

Students begin with the simplest objectives, and progress to the most complex; this approach minimizes student frustration, and allows students to measure their own success and progress. The accuracy of the curriculum is based primarily on the specific definition of the objective in terms of performance competencies. When one takes into account the target population's desire to acquire skills necessary for improvement of their basic skills to lead to better employment possibilities, one is lead directly to consider only performance objectives which are directly related to skills necessary to perform in the working world.

Criteria Number 4: the mastery learning paradigm must be employed as a basis of advance.

The effectiveness of the curriculum is directly a result of the employment of the Mastery Learning Paradigm. The fundamental approach requires that students demonstrate mastery of each basic skill before work in a higher order skill dependent on that prerequisite skills is allowed. This commitment to the mastery learning model is responsible for the effective assignment of students to the material most appropriate to their capabilities at any given point in the instructional process. This model

minimizes student frustration and enhances learner success because the most efficient use is made of the student's time.

Criteria Number 5: diagnostic and prescriptive strategies must be utilized.

The efficiency of the system is due primarily to the diagnostic inventory made of the skills of each entering learner. Each incoming student is assessed to identify skill deficiencies. This information is used to place each student appropriately within the curriculum and to direct learners to the instructional material most appropriate to their needs. The system continuously prescribes the list of available lesson strategies for a given Cluster of objectives within the Strand on which the student is currently working.

Criteria Number 6: a multi-sensory learning format must be employed.

The motivational acceptance of the Learning System is a result of extensive use of the interactive Control Data PLATO system, integrated with a multi-media support package. This multi-sensory approach is often successful with students who have difficulty achieving in text-oriented, passive learning environments.

The result-benefit of meeting each of the six stated criteria can be stated through the use of individualization strategies the Learning System becomes responsive to individual learners, through the modularized organization it becomes flexible to various learning environments, through a well organized objective base the system delivers instruction more accurately, through the use of the Mastery Learning Paradigm it is more effective in guaranteeing learning, through a diagnostic and prescriptive structure the system is much more efficient of the learner's time, and through the use of multi-sensory materials it is more motivating.

THE ANATOMY OF THE CURRICULUM

The Basic Skills curriculum encompasses three major content areas: mathematics, reading, and language skills. Each of these independent content areas is organized according to the following hierarchy:

- Objective: The objective is the smallest unit of instruction directly related to a measurable competency.
- Cluster: Objectives are organized into meaningful subsets, called clusters, according to the basic concepts with which they deal.
- Bundle: Interrelated clusters of objectives are packaged into bundles of objectives. A bundle is a grouping of clusters across which mixed practice is meaningful and retention is measured.

·Strand: A strand is a major subset of the content with a conceptual thread throughout. The nine strands in the mathematics curriculum are:

- Basic Number Ideas
- Addition
- Subtraction
- Multiplication
- Division
- Fractions
- Decimals
- Ratio-Proportion-Percent
- Geometry and Measurement

This discussion will focus on one of the strands in the mathematics curriculum, as an example of how each of the elements of the curriculum fit together.

The Fractions strand is composed of 38 specific performance objectives organized into 15 meaningful clusters. Each of these clusters consists of the following set of instruction activities: a tutorial lesson, a drill and practice lesson, a set of exercises in the student Strand Booklet, a mastery test, and a review help sequence. The clusters are further grouped into three major bundles where a mixed practice, an applications activity, and a retention test are administered. The strand takes on the following precise description:

CURRICULUM: Basic Math Skills for Adults

STRAND: Fractions

Bundle A. Basic Terminology and Concepts
- Cluster 1. The Meaning of a Fraction
- Cluster 2. Basic Terminology
- Cluster 3. The Concept of Equivalence
- Cluster 4. Comparing Fractional Numbers
- Cluster 5. Improper Fractions and Mixed Numbers

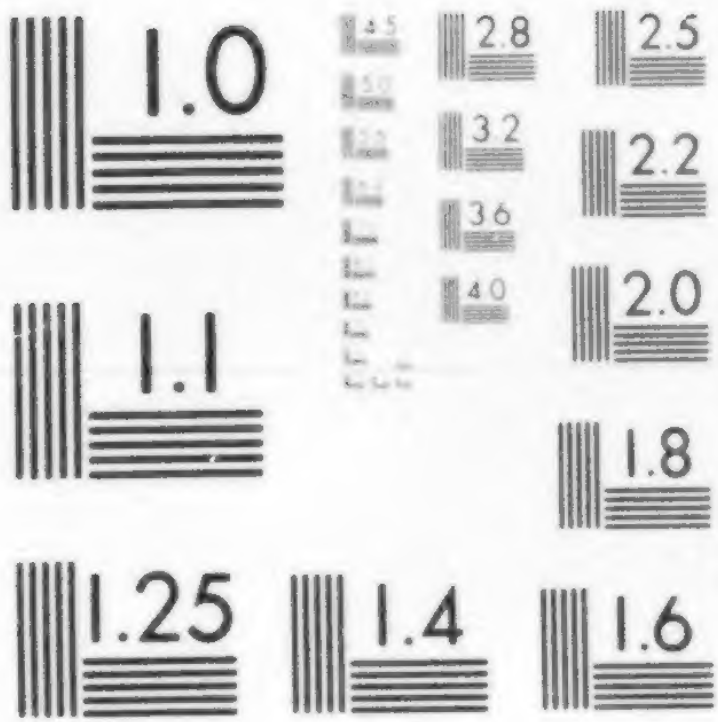
Bundle B. Addition and Subtraction
- Cluster 6. Adding and Subtracting Fractional Numbers Having the Same Denominator
- Cluster 7. Adding and Subtracting Fractional Numbers Having Different Denominators
- Cluster 8. Addition of Mixed Numbers
- Cluster 9. Subtraction of Mixed Numbers in Instances Which Do Not Require Regrouping
- Cluster 10. Subtraction of Mixed Numbers in Instances Which Require No Regrouping

Bundle C. Multiplication and Division
- Cluster 11. Multiplication of Fractional Numbers
- Cluster 12. Division of Fractional Numbers in Simple Cases
- Cluster 13. Division of Fractional Numbers in General Cases

Cluster 14. Multiplication of a Mixed Number and a Whole Number
Cluster 15. Multiplication and Division of Mixed Numbers

CONCLUSION

The Basic Skills Learning System constitutes an attempt to develop a comprehensive package for dealing with a significant educational problem. It is being constructed under conditions of a common and coordinated instructional design. Accordingly it should be possible to reap not only economic benefits from this strategy, but curricular advantages as well. It is believed that such efforts are necessary for advance in the Computer-Based Education realm.



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